

NO_x AND N₂O MEASUREMENTS**§ 1065.370 CLD CO₂ and H₂O quench verification.**

(a) *Scope and frequency.* If you use a CLD analyzer to measure NO_x, verify the amount of H₂O and CO₂ quench after installing the CLD analyzer and after major maintenance.

(b) *Measurement principles.* H₂O and CO₂ can negatively interfere with a CLD's NO_x response by collisional quenching, which inhibits the chemiluminescent reaction that a CLD utilizes to detect NO_x. This procedure and the calculations in §1065.675 determine quench and scale the quench results to the maximum mole fraction of H₂O and the maximum CO₂ concentration expected during emission testing. If the CLD analyzer uses quench compensation algorithms that utilize H₂O and/or CO₂ measurement instruments, evaluate quench with these instruments active and evaluate quench with the compensation algorithms applied.

(c) *System requirements.* A CLD analyzer must have a combined H₂O and CO₂ quench of ±2% or less, though we strongly recommend a quench of ±1% or less. Combined quench is the sum of the CO₂ quench determined as described in paragraph (d) of this section, plus the H₂O quench determined in paragraph (e) of this section.

(d) *CO₂ quench verification procedure.* Use the following method to determine CO₂ quench by using a gas divider that blends binary span gases with zero gas as the diluent and meets the specifications in §1065.248, or use good engineering judgment to develop a different protocol:

(1) Use PTFE or stainless steel tubing to make necessary connections.

(2) Configure the gas divider such that nearly equal amounts of the span and diluent gases are blended with each other.

(3) If the CLD analyzer has an operating mode in which it detects NO-only, as opposed to total NO_x, operate the CLD analyzer in the NO-only operating mode.

(4) Use a CO₂ span gas that meets the specifications of §1065.750 and a concentration that is approximately twice the maximum CO₂ concentration expected during emission testing.

(5) Use an NO span gas that meets the specifications of §1065.750 and a concentration that is approximately twice the maximum NO concentration expected during emission testing.

(6) Zero and span the CLD analyzer. Span the CLD analyzer with the NO span gas from paragraph (d)(5) of this section through the gas divider. Connect the NO span gas to the span port of the gas divider; connect a zero gas to the diluent port of the gas divider; use the same nominal blend ratio selected in paragraph (d)(2) of this section; and use the gas divider's output concentration of NO to span the CLD analyzer. Apply gas property corrections as necessary to ensure accurate gas division.

(7) Connect the CO₂ span gas to the span port of the gas divider.

(8) Connect the NO span gas to the diluent port of the gas divider.

(9) While flowing NO and CO₂ through the gas divider, stabilize the output of the gas divider. Determine the CO₂ concentration from the gas divider output, applying gas property correction as necessary to ensure accurate gas division. Record this concentration, $x_{\text{CO}_2\text{act}}$, and use it in the quench verification calculations in §1065.675. Alternatively, you may use a simple gas blending device and use an NDIR to determine this CO₂ concentration. If you use an NDIR, it must meet the requirements of this part for laboratory testing and you must span it with the CO₂ span gas from paragraph (d)(4) of this section.

(10) Measure the NO concentration downstream of the gas divider with the CLD analyzer. Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response. While the analyzer measures the sample's concentration, record the analyzer's output for 30 seconds. Calculate the arithmetic mean concentration from these data, x_{NOmeas} . Record x_{NOmeas} , and use it in the quench verification calculations in §1065.675.

(11) Calculate the actual NO concentration at the gas divider's outlet, x_{NOact} , based on the span gas concentrations and $x_{\text{CO}_2\text{act}}$ according to Equation 1065.675–2. Use the calculated value in the quench verification calculations in Equation 1065.675–1.

(12) Use the values recorded according to this paragraph (d) and paragraph (e) of this section to calculate quench as described in § 1065.675.

(e) *H₂O quench verification procedure.* Use the following method to determine H₂O quench, or use good engineering judgment to develop a different protocol:

(1) Use PTFE or stainless steel tubing to make necessary connections.

(2) If the CLD analyzer has an operating mode in which it detects NO-only, as opposed to total NO_x, operate the CLD analyzer in the NO-only operating mode.

(3) Use an NO span gas that meets the specifications of § 1065.750 and a concentration that is near the maximum concentration expected during emission testing.

(4) Zero and span the CLD analyzer. Span the CLD analyzer with the NO span gas from paragraph (e)(3) of this section, record the span gas concentration as x_{NOdry} , and use it in the quench verification calculations in § 1065.675.

(5) Humidify the NO span gas by bubbling it through distilled water in a sealed vessel. If the humidified NO span gas sample does not pass through a sample dryer for this verification test, control the vessel temperature to generate an H₂O level approximately equal to the maximum mole fraction of H₂O expected during emission testing. If the humidified NO span gas sample does not pass through a sample dryer, the quench verification calculations in § 1065.675 scale the measured H₂O quench to the highest mole fraction of H₂O expected during emission testing. If the humidified NO span gas sample passes through a dryer for this verification test, control the vessel temperature to generate an H₂O level at least as high as the level determined in § 1065.145(e)(2). For this case, the quench verification calculations in § 1065.675 do not scale the measured H₂O quench.

(6) Introduce the humidified NO test gas into the sample system. You may introduce it upstream or downstream of any sample dryer that is used during emission testing. Note that the sample dryer must meet the sample dryer verification check in § 1065.342.

(7) Measure the mole fraction of H₂O in the humidified NO span gas downstream of the sample dryer, $x_{\text{H}_2\text{Omeas}}$. We recommend that you measure $x_{\text{H}_2\text{Omeas}}$ as close as possible to the CLD analyzer inlet. You may calculate $x_{\text{H}_2\text{Omeas}}$ from measurements of dew point, T_{dew} , and absolute pressure, p_{total} .

(8) Use good engineering judgment to prevent condensation in the transfer lines, fittings, or valves from the point where $x_{\text{H}_2\text{Omeas}}$ is measured to the analyzer. We recommend that you design your system so the wall temperatures in the transfer lines, fittings, and valves from the point where $x_{\text{H}_2\text{Omeas}}$ is measured to the analyzer are at least 5 °C above the local sample gas dew point.

(9) Measure the humidified NO span gas concentration with the CLD analyzer. Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response. While the analyzer measures the sample's concentration, record the analyzer's output for 30 seconds. Calculate the arithmetic mean of these data, x_{NOWet} . Record x_{NOWet} and use it in the quench verification calculations in § 1065.675.

(f) *Corrective action.* If the sum of the H₂O quench plus the CO₂ quench is less than -2% or greater than +2%, take corrective action by repairing or replacing the analyzer. Before running emission tests, verify that the corrective action successfully restored the analyzer to proper functioning.

(g) *Exceptions.* The following exceptions apply:

(1) You may omit this verification if you can show by engineering analysis that for your NO_x sampling system and your emission calculation procedures, the combined CO₂ and H₂O interference for your NO_x CLD analyzer always affects your brake-specific NO_x emission results within no more than ±1% of the applicable NO_x standard. If you certify to a combined emission standard (such as a NO_x + NMHC standard), scale your NO_x results to the combined standard based on the measured results (after incorporating deterioration factors, if applicable). For example, if your final NO_x + NMHC value is half of the emission standard, double the NO_x result to

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estimate the level of NO_x emissions corresponding to the applicable standard.

(2) You may use a NO_x CLD analyzer that you determine does not meet this verification, as long as you try to correct the problem and the measurement deficiency does not adversely affect your ability to show that engines comply with all applicable emission standards.

[73 FR 59328, Oct. 8, 2008, as amended at 73 FR 73789, Dec. 4, 2008; 75 FR 23041, Apr. 30, 2010; 76 FR 57447, Sept. 15, 2011]

§ 1065.372 NDUV analyzer HC and H₂O interference verification.

(a) *Scope and frequency.* If you measure NO_x using an NDUV analyzer, verify the amount of H₂O and hydrocarbon interference after initial analyzer installation and after major maintenance.

(b) *Measurement principles.* Hydrocarbons and H₂O can positively interfere with an NDUV analyzer by causing a response similar to NO_x. If the NDUV analyzer uses compensation algorithms that utilize measurements of other gases to meet this interference verification, simultaneously conduct such measurements to test the algorithms during the analyzer interference verification.

(c) *System requirements.* A NO_x NDUV analyzer must have combined H₂O and HC interference within ±2% of the flow-weighted mean concentration of NO_x expected at the standard, though we strongly recommend keeping interference within ±1%.

(d) *Procedure.* Perform the interference verification as follows:

(1) Start, operate, zero, and span the NO_x NDUV analyzer according to the instrument manufacturer's instructions.

(2) We recommend that you extract engine exhaust to perform this verification. Use a CLD that meets the specifications of subpart C of this part to quantify NO_x in the exhaust. Use the CLD response as the reference value. Also measure HC in the exhaust with a FID analyzer that meets the specifications of subpart C of this part. Use the FID response as the reference hydrocarbon value.

(3) Upstream of any sample dryer, if one is used during testing, introduce the engine exhaust to the NDUV analyzer.

(4) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response.

(5) While all analyzers measure the sample's concentration, record 30 seconds of sampled data, and calculate the arithmetic means for the three analyzers.

(6) Subtract the CLD mean from the NDUV mean.

(7) Multiply this difference by the ratio of the flow-weighted mean HC concentration expected at the standard to the HC concentration measured during the verification. The analyzer meets the interference verification of this section if this result is within ±2% of the NO_x concentration expected at the standard.

(e) *Exceptions.* The following exceptions apply:

(1) You may omit this verification if you can show by engineering analysis that for your NO_x sampling system and your emission calculation procedures, the combined HC and H₂O interference for your NO_x NDUV analyzer always affects your brake-specific NO_x emission results by less than 0.5% of the applicable NO_x standard.

[70 FR 40516, July 13, 2005, as amended at 73 FR 37312, June 30, 2008; 76 FR 57447, Sept. 15, 2011]

§ 1065.375 Interference verification for N₂O analyzers.

(a) *Scope and frequency.* See § 1065.275 to determine whether you need to verify the amount of interference after initial analyzer installation and after major maintenance.

(b) *Measurement principles.* Interference gasses can positively interfere with certain analyzers by causing a response similar to N₂O. If the analyzer uses compensation algorithms that utilize measurements of other gases to meet this interference verification, simultaneously conduct these other measurements to test the compensation algorithms during the analyzer interference verification.